

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

**(19) World Intellectual Property Organization  
International Bureau**



(43) International Publication Date  
27 February 2003 (27.02.2003)

PCT

(10) International Publication Number  
**WO 2003/016826 A3**

(51) International Patent Classification<sup>7</sup>: E21B 47/00, (74) Agents: SPRINGS, Darryl, M. et al.; Baker Hughes Incorporated, Suite 1200, 3900 Essex Lane, Houston, TX 77027 (US).

(21) International Application Number:

PCT/US2002/026238

(81) Designated States (*national*): CA, GB, ID, NO.

(22) International Filing Date: 16 August 2002 (16.08.2002)

(84) Designated States (*regional*): European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR).

**(25) Filing Language:** English

## English

(26) Publication Language: English

## English

(30) Priority Data: 60/313,174 17 August 2001 (17.08.2001) US  
Not furnished 15 August 2002 (15.08.2002) US

(71) **Applicant: BAKER HUGHES INCORPORATED**  
[US/US]; 3900 Essex Lane, Suite 120, Houston, TX 77027  
(US)

(72) Inventors: CHEN, Songhua; 23015 Cable Terrace Drive, Katy, TX 77494 (US). GEORGI, Daniel, T.; 14202 Chadbourne, Houston, TX 77079 (US)

#### **Declarations under Rule 4.17:**

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations CA, GB, ID, NO, European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR)
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations

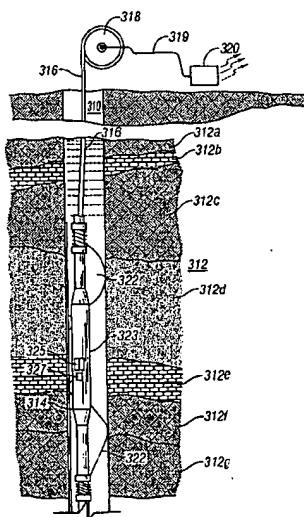
**Published:**

— with international search report

(88) Date of publication of the international search report:  
12 February 2004

[Continued on next page]

**(54) Title: IN-SITU HEAVY-OIL RESERVOIR EVALUATION WITH ARTIFICIAL TEMPERATURE ELEVATION**



**(57) Abstract:** Many reservoirs of interest include heavy oil. In such reservoirs, particularly at normal temperatures, many instruments commonly used for formation evaluation may not be able to distinguish between heavy oil and bound water in the formation. Passive or active heating is used to elevate the temperature of the fluids in the formation. At elevated temperatures, distinguishing between heavy oil and bound water is easier. Of particular interest is the increase in the resolvability of the transverse relaxation time  $T_2$  of NMR spin echo measurements. Additionally, the dielectric constant and the loss tangents of water and heavy oil show different temperature and frequency dependence.

WO 2003/016826 A3



*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US02/26258

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : E21B 47/00; G01V 3/00  
US CL : 166/250.01, 252.2, 254.2; 324/300, 309

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 166/250.01, 252.2, 254.2, 252.5, 272.1; 324/300, 309, 307, 318

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WEST

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,338,567 A (Coates) 6 July 1982, entire document.	1-36
A	US 5,432,446 A (MacInnis et al) 11 July 1995, entire document.	1-36
A	US 6,166,540 A (Wollin) 26 December 2000, entire document.	1-36
A	US 6,388,441 A (Chen) 14 May 2002, entire document.	1-36
A	US 6,470,274 A (Mollison et al) 22 October 2002, entire document.	1-36

 Further documents are listed in the continuation of Box C. See patent family annex.

•	Special categories of cited document:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

21 NOVEMBER 2002

Date of mailing of the international search report

28 OCT 2003

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20251

Facsimile No. (703) 305-3230

Authorized officer  
FRANK S. TSAY

Telephone No. (703) 308-2170